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SECOND REPORT

**National Steering Committee for
Application of Pesticides -
Gypsy Moth And Other Eastern Defoliators**

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I. INTRODUCTION

The meeting was held at the Holiday Inn, Ohio Center, Columbus, Ohio, on November 1-2, 1989.

A. Committee Members

Leah Bauer	NC/FIDR (E. Lansing, MI)
Leo Cadogen	FPMI (Sault Ste. Marie, Ontario)
Tony Chiotakis	North Carolina Department of Agriculture (Raleigh, NC)
John Cunningham	FPMI (Sault Ste. Marie, Ontario)
Don Henry	California Department of Food & Agriculture (Sacramento, CA)
Harold Flake	R-8/FPM (Atlanta, GA)
Michelle Frank	NA/FPM (Durham, NH)
Alice Jones	SE/FIDR (Athens, GA)
Win McLane	APHIS (Otis AFB, MA)
Mike McManus	NE/FIDR (Hamden, CT)
Steve Munson	R-4/FPM (Ogden, UT)
Max Ollieu	WO/FPM (Washington, DC)
Dick Reardon	NA/FPM/AIPM (Morgantown, WV)
Dan Twardus	NA/FPM (Morgantown, WV)
Barry Towers	PA Bureau of Forestry (Middletown, PA)
Jack Barry (Chair)	WO/FPM (Davis, CA)

Alice Jones and Dan Twardus were not in attendance. Copies of individual committee member reports by John Cunningham, Harold Flake, Win McLane, Steve Munson, Michelle Frank, and Barry Towers are enclosed in Appendix A.

B. Purpose of Committee

The purpose of the committee is to review, identify, and recommend needs for field tests, pilot projects, and demonstrations of aerial application of pesticides. Needs include those associated with

pesticides, application systems, techniques, and strategies that influence the USDA Forest Service's and State cooperator's ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

C. Operating Guidelines

Operating guidelines generic to the four FPM national steering committees are enclosed in Appendix B. Supplemental to these guidelines the committee adopted two additional guidelines: 1. The committee shall on an annual basis consider input/recommendations from the National Gypsy moth/Bacillus thuringiensis (B.t.) committee (see Appendix C); and 2. On an annual basis the committee shall recommend tank mixes for suppression and eradication of gypsy moth.

II. RECOMMENDATIONS

A. Laboratory

1. Investigate relationship of drop size to drop number, potency and efficacy to control gypsy moth.

   High - NEFAAT

2. Investigate impact of B.t. and Dimilin on non-target organisms through conduct of literature searches, contacts with Forest Pest Management Institute (FPMI), and field studies.

   High - Mike McManus

3. Develop a plan to characterize B.t. and Dimilin tank mixes for physical properties, atomization, and evaporation.

   High - Jack Barry

4. Develop a plan to obtain spread factors for tank mixes used to control gypsy moth.

   High - Jack Barry

5. Investigate canopy architecture of eastern deciduous forests (shape, sub-canopies, density, leaf-area index, etc.) for input and enhancement of FSCBG aerial spray model.

   High - Mike McManus

6. Develop a carrier for Gypchek.

   High - Mike McManus

7. Develop a process leading to the commercial production of Gypchek.

   Medium - FIDR

8. Investigate the "Henderson" carrier as a suitable, and physically and biologically acceptable carrier for Gypchek and B.t. formulations.

Medium - Win McLane

9. Screen tank mixes for effects on automobile paint surfaces.

Low - Win McLane

10. Investigate enzyme link immunosorbant assay (ELISA) or other techniques for rapid on-site determination of tank mix potency.

High - Pat Shea

B. Field Tests

1. Conduct field test(s) to compare insect efficacy resulting from applications with rotary and hydraulic atomizers using operational tank mixes of B.t.

High
Priority 1 - NEFAAT

2. Conduct field test of Foray 48B comparing efficacy of 16 BIU applied 96 ounces per acre to 36 BIU applied 96 ounces per acre.

High
Priority 2 - Mike McManus

3. Conduct field test of Gypchek comparing efficacy of standard dose to two lower doses.

High
Priority 3 - Mike McManus

4. Conduct field test to compare efficacy of an operational tank mix of B.t. to a B.t. tank mix containing the "Henderson" carrier.

High
Priority 4 - Win McLane

5. Conduct field tests of lower doses and lower volumes of Dimilin.

High
Priority 5 - Win McLane

6. Conduct field test of Mycogen B.t. product Myx 8242 subject to obtaining an experimental use permit.

High
Priority 6 - Mike McManus

C. Demonstration Projects

1. Demonstrate control strategy of using multiple applications of Gypchek against small (50-75 acre) isolated infestations of gypsy moth.

   High - Win McLane

2. Evaluate capability of FSCBG aerial spray model to predict predict penetration of a B.t. spray into an oak canopy.

   High - Jack Barry

3. Demonstrate utility of the gypsy moth phenology model supported by Omni-Data weather monitoring system to predict application timing.

   High - Steve Munson

D. Pilot Projects

1. Conduct a pilot project to test Foray 48B, 36 BIU, applied undiluted at 96 ounces per acre to determine if the application can consistently reduce gypsy moth populations.

   High
   Priority 1 - AIPM

2. Conduct a pilot project to test efficacy under operational conditions Dipel 8AF, 20 BIU, applied undiluted at 40 ounces per acre.

   High
   Priority 2 - AIPM

E. Equipment, Models, and Technology Development

1. Investigate both ground and aerial application equipment systems and methods to control hemlock woolly aldegid.

   High - Michelle Frank

2. Investigate and demonstrate weather monitoring systems to support gypsy moth control projects and plan for personnel training in use of the systems.

   High - Harold Flake

3. Evaluate utility of FSCBG aerial spray model to predict canopy penetration model by comparing deposition predictions to observed prediction in eastern deciduous canopies.

   High - NEFAAT

4. Review aircraft guidance and treatment block marking methods and publish a report that outlines equipment, methods, and advantages and disadvantages of each method.

High - MTDC

F. Administrative

1. Concurred with recommendation of the western defoliator steering committee to meet jointly in 1990. Harold Flake and Steve Munson agreed to host the meeting to be held in Salt Lake City, UT, November 6-8, 1990.

2. Recommend development of state-of-the-art guidelines on timing of pesticide treatments to control gypsy moth.

3. Recommend research on gypsy moth monitoring and application timing.

4. Recommend that the Dan Twardus gypsy moth monitoring data-base be made available annually to State cooperators and to this committee.

5. Recommend development and conduct of an east-wide pesticide-use training workshop annually for control of eastern defoliators.

6. Pesticide tank mix recommendations for 1990 suppression[1]:

Product[2]	BIU/Acre	Volume/Acre
Thuricide 32LV	16 - 20	96 - 128
Thuricide 48LV	"	"
SAN 415	"	"
Dipel 6L	"	"
Dipel 8L	"	"
Dipel 8AF	"	"
Foray 48B	"	"
Dimilin 25W	(3)	128

Footnotes:

(1) For eradication double treatment required.

(2) Stickers essential with oil-base tank mixes. For Thuricide, SAN 415, and Dipel use 2% Bond or 2% Plyac per volume. For Foray 48B use 2% Plyac or 2% NuFilm.

(3) Apply Dimilin @ 0.03 AI (2 oz) per gallon per acre.

III. ACCOMPLISHMENTS AND NEEDS

Summarized below are accomplishments related to 1988 committee recommendations.

A. Cooperative Field Experiments and Pilot Projects

1. Gypchek was pilot tested in Virginia against high population densities achieving population reductions, uncorrected, of 60 percent.

2. Novo Foray 48B, B.t., was field tested and results showed excellent control. (See Appendix A, Win McLane's report)

3. Undiluted Foray 48B (12 BIU and 32 ounces per acre; 24 BIU and 64 ounces per acre; and 36 BIU and 96 ounces per acre) provided population reduction, uncorrected of 85 percent, 47 percent and 97 percent respectively.

4. Efficacy of registered tank mixes as function of drop size and nozzle type (rotary vs hydraulic) was not field tested.

B. Technical

1. A Task Group composed of Jack Barry and Dick Reardon contracted for and produced a comprehensive literature review report on spray accountancy. The review covered three decades of U.S. Army chemical and biological agent testing. The report includes data on how much aerial spray volume was accounted for and how much spray drifted downwind. Copies are available from Jack Barry (916) 758-4600 or Dick Reardon (304)291-4891.

2. FPM/WO (Davis) has contracted Continuum Dynamics, Inc. to enhance and support technology transfer and field testing of the FSCBG aerial spray model. During the past year several reports were published, papers presented, and training sessions conducted.

3. FPM/WO, R-6, NA, and MTDC cooperated in use of the AGDISP model to predict swath widths for aircraft used to treat gypsy moth. A draft report will be available in December 1989 from NA.

4. Spray block identification and aircraft guidance continues to be a major problem. No field projects were conducted during 1989 to address this need.

5. Representative spread factors that consider variable drop spreading due to moisture are needed. No laboratory or field work was done on this problem. John Cunningham reported that FPMI determines the representative spread factor in the laboratory after the field work. This procedure includes simulating field conditions in the laboratory to mimic field conditions. Unfortunately, this after-the-fact procedure would not be useful to persons characterizing aircraft during operational projects.

C. Administrative

1. Guidelines for pilot testing have been prepared and extensively reviewed. A current draft will be incorporated in Forest Service Handbook (FSH) by Dennis Hamel and copies of the guidelines are available from Jack Barry (916)758-4600.

2. Guidelines for field testing have been prepared and extensively reviewed. A current draft is available from Pat Shea (916)758-4600.

3. A 5-year B.t. research and development program has not been developed.

4. Procedures are being developed by NA (Dan Twardus) to monitor gypsy moth suppression projects in the East. State cooperators expressed an interest in receiving copies of these monitoring reports. Copies are available from Dan (304)291-4133.

5. Jim Space and Max Ollieu have scheduled a visit to FPMI on December 19-20, 1989 to explore opportunities for closer ties between FPMI and FPM. (Note that the meeting was productive and that a Memorandum of Understanding is being drafted on cooperation between FPMI and Forest Pest Management.)

IV. SUMMARY

The National Steering Committee for Aerial Application of Pesticides - Gypsy Moth and Other Eastern Defoliators met in Columbus, OH, November 1-2, 1989 to develop recommendations for field experiments and pilot projects to support management of gypsy moth and other eastern defoliators. The committee was composed of representatives from Canada, the States, and Forest Service (Research and S&PF). Committee members presented individual reports on field activities (field tests, pilot projects, and operational projects) conducted during 1989. Testing and related needs were discussed, and recommendations developed. The committee concurred with the Western Defoliator Steering Committee's recommendation to meet jointly with this committee in Salt Lake City, UT, November 6-8, 1990.

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APPENDIX A
J.C. Cunningham

EXPERIMENTAL AERIAL APPLICATION OF DISPARVIRUS

FOR CONTROL OF GYPSY MOTH IN ONTARIO:

REDUCED DOSAGE AND EMITTED VOLUME

Report to the Seventeenth Annual Pest Control Forum

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November 1989

EXPERIMENTAL AERIAL APPLICATION OF DISPARVIRUS FOR CONTROL OF GYPSY MOTH IN ONTARIO: REDUCED DOSAGE AND EMITTED VOLUME

Summary

Following successful Disparvirus trials in 1988 with a double application of $1.25X10^{12}$ PIB/ha (total $2.5X10^{12}$ PIB/ha) in an emitted volume of 10.0 L/ha, a reduced double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) was tested in emitted volumes of 10.0 L/ha and 5.0 L/ha. The 10.0 L/ha application was applied on three 10 ha plots and the 5.0 L/ha application on three 20 ha plots. Total treated area was 90 ha. The tank mix contained 25% v/v molasses, 10% w/v Orzan LS as a UV protectant and 2% v/v Rhoplex B60A spreader-sticker. A Cessna Ag-truck fitted with 4 Micronair AU 4000 rotary atomizers was used for the first application and a Piper Pawnee fitted with 6 Micronair AU 5000 atomizers was used for the second application 3 days later. Larvae were mainly in their first instar at the time of these applications. A further 3 plots were selected as untreated checks. Pre-spray gypsy moth egg mass densities ranged from 2,180/ha to 11,900 in the six treated plots and from 2,000 to 6,380 in the three check plots.

A detailed assessment involved pupal counts in burlap traps, pre-spray and post-spray egg mass counts, weekly records of the incidence of NPV in treated and check plots and estimates of defoliation of oak trees. High levels of virus infection were observed in samples collected 2 weeks post-spray with 71, 81 and 100% of the larvae infected in plots sprayed at 10.0 L/ha and 71, 91 and 97% in plots sprayed at 5.0 L/ha compared to 3, 4 and 5% naturally occurring infection in the check plots.

The number of pupae/m of burlap trap ranged from 13 to 99 in the check plots, 4 to 6 in the plots treated at 10.0 L/ha and 4 to 22 in plots treated at 5.0 L/ha. There were considerable (undefined) numbers of forest tent caterpillars in all the plots which increased the extent of defoliation. However, defoliation of oak was significantly less in all the treated plots compared to check plots with defoliation ranging from 75 to 82% in check plots compared to 28 to 46% in plots treated at 10.0 L/ha and 19 to 38% in plots treated at 5.0 L/ha. There was no significant difference in reduction of egg mass densities between the 10.0 L/ha and 5.0 L/ha treatments, but egg mass densities in both treatments were significantly lower than those in the check plots; population reductions in the 10.0 L/ha treatments, calculated using a modified Abbott's formula, were 79, 79 and 85% and in the 5.0 L/ha treatments were 80, 85 and 98%. Hence, an application volume of 5.0 L/ha is recommended for Disparvirus in preference to 10.0 L/ha. These trials also indicate that a reduction in dosage of Disparvirus from $2.5X10^{12}$ to 10^{12} PIB/ha may be feasible, although any further reduction would not be advisable.

Introduction

Aerial spray trials were conducted in Ontario in 1988 when a double application of $1.25X10^{12}$ PIB/ha (total $2.5X10^{12}$ PIB/ha) was applied to 3 plots in an emitted volume of 10.0 L/ha when larvae were mainly in their first instar. It is necessary to rear, infect, harvest and process about 1,000 gypsy moth larvae to produce a 1 ha dosage of $2.5X10^{12}$ PIB. Foliage protection and reduction in egg mass densities were outstanding following these applications in 1988, far exceeding the parameters regarded as acceptable. These parameters are defined as defoliation of less than 40% in treated blocks and reduction in egg mass densities to below a threshold level of 1,200 egg masses/ha; control measures are advocated above this level.

The dosage used in 1988 is quite high and the application volume of 10.0 L/ha, although widely used for virus applications, is considered unacceptably high for forestry applications in Canada. Hence, in 1989 it was decided to evaluate a lower dosage and a lower emitted volume. The dosage selected was a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha). It requires 400 gypsy moth larvae to produce this dosage which was applied in two different emitted volumes, 10.0 L/ha, the same as used in 1988, and 5.0 L/ha.

Experimental plots and spray application

Six treatment plots and three check areas were selected in Lindsay District. Two treated plots were on Otonobee Conservation Authority property near Clear Lake, north of Lakefield and one check plot was on private land nearby. The remaining four treated plots and two check areas were on Duro Conservation Authority land and private land near Round Lake, north of Havelock.

Table 1. Meteorological conditions during spray applications.

Date	Air temp (°C)	Ground temp (°C)	% RH	Wind (km/h)
24 May	14-15	13-14	80-85	1-2
27 May	9	8	78-84	5-8

Table 2. Larval development at time of application.

Plot	Application	%L1	%L2	%L3
1	1	99.1	0.9	-.-
	2	86.3	13.7	-.-
2	1	100.0	-.-	-.-
	2	94.6	5.4	-.-
3	1	90.2	9.8	-.-
	2	51.1	41.1	7.8
4	1	100.0	-.-	-.-
	2	70.6	27.4	2.0
5	1	91.1	7.1	1.8
	2	56.0	38.0	6.0
6	1	98.2	1.8	-.-
	2	94.5	5.5	-.-

Table 3. Spray deposit on Kromekote cards.

Plot	Application number	NMD (μm)	VMD (μm)	Dmax (μm)	#Droplets/ cm^2 (± SE)
2	1	48	278	461	3.8 ± 2.5
	2	105	241	597	18.5 ± 16.3
3	1	61	370	938	63.6 ± 27.3
	2	109	303	734	43.3 ± 24.3
4	1	29	158	427	21.5 ± 8.7
5	1	23	248	392	22.6 ± 10.6
	2	101	347	665	10.0 ± 8.0
6	1	40	283	495	64.4 ± 37.0
	2	144	291	631	9.8 ± 3.5

The same dosage was applied to all 6 plots. It was a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha). Two different emitted volumes were tested, 10.0 L/ha and 5.0 L/ha. Plots treated at 10.0 L/ha (designated 1,2,3) were 10 ha and plots treated at 5.0 L/ha (designated 4,5,6) were 20 ha in area. Hence, a total area of 90 ha was sprayed with Disparvirus in 1989. The tank mix contained 25% v/v molasses, 10% Orzan LS, a lignosulphonate used as a UV protectant, and 2% v/v Rhoplex B60A spreader-sticker. The first spray on May 24th was applied by the FPMI Cessna Ag-truck fitted with 4 Micronair AU 4000 rotary atomizers. The second spray, 3 days later, on May 27th was applied by a Piper Pawnee fitted with 6 Micronair AU 5000 rotary atomizers. Meteorological conditions during the applications are given in Table 1. Gypsy moth larval development is given in Table 2. Oak leaves were about 50% expanded on red oak and 25% expanded on white oak at the time of application. Kromekote cards were placed at 15 m intervals at right angles to flight lines in some of the plots where this was practical. Results of the analysis of these cards is given in Table 3, although there may be anomolies due to masking of some cards by foliage and spray drift away from the card line.

Assessment

Egg mass counts were made on ten 10 m^2 (0.01 ha) sub-plots in each treated and check plot using methods established by Forest Insect and Disease Survey staff. Numbers were converted to egg masses per hectare. Counts were made in early May before hatching commenced and the same plots were re-examined in mid-October. Reduction in egg mass density was calculated using a modified Abbott's formula; treated and check plots with corresponding pre-spray egg mass counts were paired for this calculation.

Incidence of virus infection was estimated pre-spray, between the two spray applications and at weekly intervals post-spray in all the treated and check plots. Random samples of larvae were collected at eye level on understory vegetation (100 to 200 per plot), smeared on microscope slides, stained with naphthalene black 12B and examined at 1,200X magnification for the presence of PIBs. Larvae were not collected in the vicinity of the 0.01 ha sub-plots used for egg mass counts.

Pupal counts were made from burlap traps on three oak (red or white) trees in each of the ten 0.01 ha plots used for egg mass counts in all the treated and check plots. Strips of burlap, 450 cm wide, were folded double and nailed to the trunks of trees. The circumference of sample trees was measured and pupal counts converted to numbers-per-metre of burlap trap. These counts were made on July 11 and 12 at 7 weeks post-spray.

Defoliation estimates were made on 10 red oak or white oak 46-cm branch tips collected at mid-crown from trees in the ten 0.01 ha egg-mass sampling plots. This was done at 7 weeks post-spray when larvae had ceased feeding and were either pupating or dead. A total of 100 branch tips was examined in each treated and each check plot. An estimate of the amount of foliage missing from each branch was made and a mean calculated for each plot.

Results

Incidence of virus infection in the 6 treated and three corresponding check plots is shown in Fig. 1. Peaks of NPV infection were reached 2 weeks post-spray in the 6 treated plots and ranged from 71% to 100% of the larvae infected in the samples. Only 3 to 5% of larvae in the check plots were infected. Incidence of virus infection then dropped until 6 to 7 weeks post-spray when it again increased. At this time high levels were also recorded in the check plots, ranging from 50 to 94% of larvae infected. As pupation had commenced, figures for incidence of virus infection can become distorted because healthy larvae have pupated and a high percentage of the remaining larval population is infected.

Pupal counts are given in Table 4. Significant differences were recorded in numbers from the treated plots and corresponding check plots. Numbers of pupae/m of burlap trap ranged from 21 to 93 in the check plots and from 4 to 27 in the treated plots.

Egg mass counts in the spring and fall are given in Table 4 along with the population reductions due to treatment calculated using a modified Abbott's formula. Population reductions in the 3 plots sprayed at 10.0 L/ha were 79, 79 and 85% and in the 3 plots sprayed at 5.0 L/ha were 80, 85 and 98%. The results with the 5.0 L/ha treatment were marginally better than the 10.0 L/ha treatment, but this difference is not statistically significant.

Defoliation estimates are also given in Table 4. There was a significant difference in the degree of defoliation between all treated and check plots. However, results were confounded by moderate to high populations of forest tent caterpillar, *Malacosoma disstria*, in all nine plots, although it was impossible to quantify population densities. Defoliation in the three untreated check plots ranged from 75 to 82% and in the six treated plots ranged from 19 to 46%.

Discussion

The reductions in dosage and emitted volume tested in 1989 are considered effective and both are most desirable achievements if Disparvirus is to become an operational pest management alternative for gypsy moth control. The applications at 5.0 L/ha were marginally better than those at 10.0 L/ha. This is possibly due to better atomization of droplets by Micronair units at the reduced flow rate. Due to the negligible difference between the two application volumes, all six plots treated with the same dosage can be compared as replicates. Of these 6 replicates, three were excellent, two were borderline and one did not meet the criterion of a reduction in egg mass densities to below 1,200/ha. However, in this plot, egg mass density was reduced from 11,900/ha to 2,200/ha which, in itself, was a major accomplishment. Perhaps Disparvirus applications are not so effective on gypsy moth population densities in excess of 8,000 to 10,000 egg masses per hectare. One should possibly consider Disparvirus applications two years in

Fig. 1. Incidence of NPV-infected larvae in plots treated with Disparvirus and in corresponding check plots.

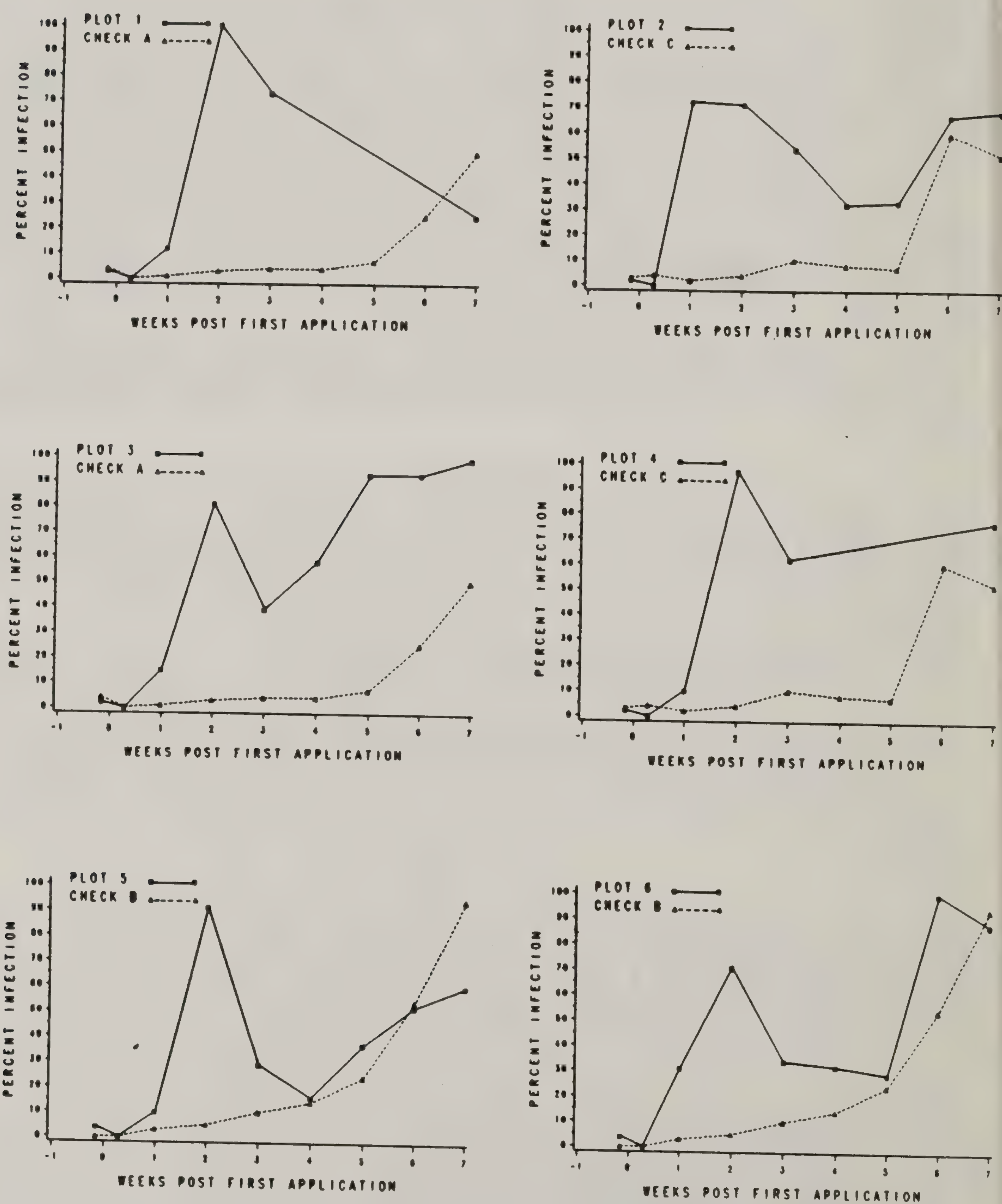

Table 4. Assessment of Disparvirus aerial spray trials.

Plot	Emitted volume (L/ha)	Pupae/m burlap (±S.E.)	Pre-spray E.M./ha (±S.E.)	Post-spray E.M./ha (±S.E.)	% Population reduction due to treatment[1]	% Defoliation of oak
Plot 1	10.0	27±9	2990±326	1130±246	79	46
Check A	-	93±14	2920±407	5320±1193	-	75
Plot 2	10.0	9±3	2180±199	370±106	85	28
Check C	-	21±3	2000±215	2230±414	-	82
Plot 3	10.0	4±1	3170±575	1230±392	79	28
Check A	-	93±14	2920±407	5320±1193	-	75
Plot 4	5.0	10±2	2490±258	540±176	85	38
Check C	-	21±3	2000±215	2230±414	-	82
Plot 5	5.0	22±8	11900±3778	2220±1190	80	28
Check B	-	91±13	6380±1877	5810±888	-	81
Plot 6	5.0	4±1	6730±1579	150±32	98	19
Check 5	-	91±13	6380±1877	5810±888	-	81

[1] Calculated using a modified Abbott's formula.

succession when attempting to control very high density gypsy moth populations.

It is difficult to apply the parameter set for foliage protection in these trials because of undetermined defoliation attributed to forest tent caterpillar in the whole general area. However, defoliation was significantly lower in all the treated plots compared to the check plots and the Disparvirus treatments had an obvious and clearcut impact in saving oak foliage. Only one treated plot did not meet the guideline of under 40% defoliation. This was plot 1 with 46% defoliation; obviously without the intervention of forest tent caterpillar, it too would have been classified as adequately protected.

Some of the very high levels of virus infection recorded two weeks post-spray, followed by moderate pupal and egg mass counts, leads one to doubt the validity of this means of assessment. One would have anticipated virtual eradication of the population and this did not occur. Larvae that were sampled at eye level on understory vegetation were almost all infected with NPV in some samples. This leads one to ask two questions 1) should samples of larvae have been collected from mid-crown or higher in the trees and 2) were the treated plots re-infested by larvae from adjoining, heavily defoliated areas?

Conclusions and recommendations

From the above results, it is evident that an emitted volume of 5.0 L/ha is as good as, if not better than, 10.0 L/ha, provided it is applied using Micronair rotary atomizers or equipment giving a similar droplet spectrum. A further reduction in emitted volume should be investigated and it is hoped to compare 2.5 L/ha to 5.0 L/ha in 1990.

The double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) applied in 1989 is considered to be the lowest feasible dosage and lower dosages are not recommended. In fact, a higher dosage is desirable, but economic factors come into play. It is necessary to rear, infect, harvest and process 400 gypsy moth larvae to produce 10^{12} PIBs. How much will this cost? Is it competitive with Bacillus thuringiensis? These questions are academic until Disparvirus (or another viral insecticide for gypsy moth) is commercially available.

FPMI staff is in contact with two companies who are interested in producing a viral insecticide for gypsy moth. The first is Espro, located in Maryland, USA and the second is Calliope, in France. At present, it appears improbable that either company will have a product available for field trials in Canada in 1990. Hence, any field trials conducted next year will use Disparvirus produced at FPMI.

This research was funded in part by an Ontario Pesticides Advisory Committee grant.

DEPOSITION AND EFFICACY OF DIPEL 8AF APPLIED DILUTED AND UNDILUTED AGAINST THE GYPSY MOTH (LEPIDOPTERA: LYMANTRIIDAE) IN SOUTHEASTERN ONTARIO

Information Report FPM-X-84
1989

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Cette publication est aussi disponible en français sous le titre: *Caractéristiques du dépôt et efficacité du Dipel 8AF, en solution ou non, contre la spongieuse (Lepidoptera: Lymantriidae) dans le sud–est de l'Ontario.*

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Van Frankenhuyzen, K., Howard, C., Churcher, G., Howse, G., Lawrence, D. 1989. Deposition and efficacy of Dipel 8AF applied diluted and undiluted against the gypsy moth (Lepidoptera: Lymantriidae) in southeastern Ontario. Forestry Canada, Sault Ste. Marie, Ont. Forest Pest Management Institute Inf. Rep. FPM-X-84, 11 p.

ABSTRACT

The feasibility of ultra-low volume application of undiluted *Bacillus thuringiensis* formulations for control of the gypsy moth was examined by treating three oak stands with Dipel 8AF at 15 BIU in 0.9 L/ha (undiluted) or at 30 BIU in 1.8 L/ha (undiluted) and 6.0 L/ha (diluted). Branches were collected from upper, middle and lower canopy and assayed for spray deposits as well as toxicity to third-instar gypsy moth larvae. Droplet size distributions in the two undiluted treatments were similar with a number median diameter (NMD) of 49-55 μm and a volume median diameter (VMD) of 117-126 μm. The diluted application resulted in a broader size distribution, with an NMD of 98 μm and a VMD of 180 μm. Droplet density was significantly higher in the 1.8 and 6.0 L/ha treatments (5-10 droplets/cm^2) than in the 0.9 L/ha treatment (3-5 droplets/cm^2). Droplet density decreased significantly from upper to lower canopy in each spray block. Mortality of gypsy moth larvae in the bioassays reached about 50% in the 1.8 and 6.0 L/ha treatments and 30% in the 0.9 L/ha treatment. Regression analysis of mortality versus observed droplet density in the bioassays did not differ between treatments. For both diluted and undiluted applications, a density of 8-10 droplets/cm^2 was required to obtain 50% mortality. All treatments resulted in lower defoliation and egg mass density than in untreated areas, but declining populations confounded the assessment. Application of undiluted formulations containing 16.9 BIU/L in 1.8 L/ha can be recommended for operational control of gypsy moth. The feasibility of using higher potency products in even lower volumes needs to be assessed in future programs.

RÉSUME

La possibilité d'appliquer en très faible volume des formulations non diluées de *Bacillus thuringiensis* pour lutter contre la spongieuse a été examinée : on a traité trois peuplements de chênes avec du Dipel 8AF à 15 UBI par 0,9 L/ha (forme non diluée) ou 30 UBI par 1,8 L/ha (forme non diluée) ainsi que 6,0 L/ha (forme diluée). Des branches ont été prélevées aux niveaux supérieur, intermédiaire et inférieur de la cime; les dépôts laissés par pulvérisation ainsi que la toxicité chez les larves du troisième stade de la spongieuse ont été étudiés. La distribution par taille des gouttelettes était semblable dans les deux traitements avec le produit non dilué, soit avec un diamètre médian en fonction du nombre (DMN) de 49-55 μm et un diamètre médian en fonction du volume (DMV) de 117-126 μm. L'application du produit dilué a eu pour effet d'élargir la distribution des gouttelettes; le DMN était de 98 μm et le DMV était de 180 μm. Il y avait une densité significativement supérieure des gouttelettes lors des traitements à 1,8 et 6,0 L/ha (5-10 gouttelettes/cm^2) que lors du traitement à 0,9 L/ha (3-5 gouttelettes/cm^2). Il y avait une réduction significative de la densité des gouttelettes du niveau supérieur au niveau inférieur de la cime dans chaque parcelle traitée. Lors des essais biologiques, la mortalité des larves de la spongieuse se chiffrait à environ 50 % dans les groupes traités à 1,8 et 6,0 L/ha et atteignait 30 % dans le groupe traité à 0,9 L/ha. Il n'y avait pas de différence entre les différents traitements quant à l'analyse par traitements et quant à l'analyse par régression de la mortalité dans les bioessais par rapport à la densité observée des gouttelettes. Que ce soit sous forme diluée ou non, il fallait une densité de gouttelettes de 8-10 gouttelettes/cm^2 pour atteindre une mortalité de 50 %. Tous les traitements ont atténué la défoliation et diminué la densité des masses d'oeufs, par rapport aux secteurs-témoins, mais les populations généralement faibles de larves n'ont pas aidé à l'évaluation. L'application de formulations sous forme non diluée et contenant 16,9 UBI/L dans 1,8 L/ha peut être recommandée pour les traitements opérationnels de la spongieuse. Il est suggéré de vérifier la possibilité d'utiliser des produits plus actifs et un volume encore moindre lors des futurs programmes.

INTRODUCTION

Bacillus thuringiensis Berliner is widely used for control of the gypsy moth, *Lymantria dispar* L., in eastern North America. Aerial control operations usually involve application of diluted formulations in 6-9.5 L/ha (Grimble and Lewis 1985). Such high volume application rates were used for control of the eastern spruce budworm, *Choristoneura fumiferana*: high-potency formulations became available in the early 1980s (Morris 1984). These formulations contain 12.7 Billion International Units (BIU)/L or more and can be applied undiluted at 30 BIU/ha in 2.4 L or less. Application of undiluted formulations has substantially reduced costs of spruce budworm control operations (Irland and Rumpf 1987), and would have similar benefits in gypsy moth control programs.

Ultra-low volume (ULV) application requires efficient atomization of the spray formulation into small droplets. Micronair rotary atomizers can generate a high proportion of droplets <100 μm in diameter from undiluted high-potency formulations (Yates and Cowden 1986; Van Vliet and Picot 1987). Such droplets impinge effectively on coniferous foliage (Picot et al. 1986) and are efficacious against several defoliators at densities of one droplet per needle or less (Fast et al. 1986; West et al. 1987; Cadogan et al. 1986). However, data are needed on deposition of small droplets in a hardwood canopy and their effectiveness against hardwood defoliators.

A cooperative study was initiated in 1987 to examine droplet deposition and distribution in relation to droplet size in an oak forest canopy following application of diluted and undiluted formulations. The study involved the Forest Pest Management Institute (FPMI) of Forestry Canada, the New Brunswick Research and Productivity Council (RPC) and Abbott Laboratories. The study was continued in 1988 in cooperation with the Pest Management Section of the Ontario Ministry of Natural Resources (OMNR) and the Forest Insect and Disease Survey (FIDS) of Forestry Canada. Specific objectives were: (1) to examine droplet deposition in an oak canopy in relation to application volume under operational spraying conditions; (2) to relate observed spray deposits to gypsy moth mortality in bioassays of sprayed foliage; (3) to assess efficacy of diluted and undiluted treatments in terms of foliage protection and egg mass reduction; and (4) to examine feasibility of undiluted application at half the recommended application rate. These objectives were addressed by treating six blocks at 30 or 15 BIU/ha in 0.9 L (three replicates), 1.8 L (two replicates) or 6.0 L (one replicate). The Pest Management Section was in charge of spray application. Spray deposition was assessed by RPC in each spray block and is the subject of a separate report. Biological assessment was conducted by FIDS and FPMI in the three blocks that had suitable gypsy moth populations, one in each treatment, and those results are reported here.

MATERIALS AND METHODS

Research Site

The experiment was conducted in May 1988 in Lavant Township in southeastern Ontario (Fig. 1). The selected blocks (50 -230 ha) contained predominantly red oak (*Quercus rubra* L., 60-90%) and red maple (*Acer rubrum* L., 10-40%), with a light mix of white birch (*Betula papyrifera* Marsh.), poplar (*Populus balsamifera* L.), balsam fir (*Abies balsamea* L.), and sugar maple (*A. saccharum* Marsh.). Dominant trees were generally 15-20 m in height. In each block a total of 15 oak trees were selected at 20-40 m intervals in a line perpendicular to flight direction of the spray aircraft. Crown height of the sample trees varied between 12 and 18 m.

Gypsy moth infestation in the three blocks was first detected in 1986. Populations in block A and B were high enough (>1200 egg masses/ha) to warrant aerial treatment with *B. thuringiensis* in 1987. Block B was scheduled for treatment in 1988 as well and OMNR agreed to allocate half of the 700 ha spray block, with appropriate buffer zones, to our experimental program. Block C formed a natural extension of the infestation in block B.

Application

All blocks were treated with Dipel 8AF (ABG 6167), which is an aqueous flowable formulation produced by Abbott Laboratories (Chicago, Ill.) that contains 16.9 BIU/L. To facilitate deposit assessment, Erio acid red dye XGN250 (St. Lawrence Aniline, Brockville, Ont) was added as a tracer at 0.4% (weight:volume). The mixture was applied by a Piper Brave fitted with four Micronair AU4000 atomizers. The aircraft flew 15-25 m above the canopy at 180 km/h using 60-m lane separations and was guided by a Cessna 172 pointer aircraft. Both planes operated from a private airstrip at Westport. Dipel was applied undiluted in 1.8 L/ha (block A) and 0.9 L/ha (block B) or diluted with water in a 1:2.33 ratio in a total volume of 6.0 L/ha (block C). Sprays were applied under standard operational conditions in the early morning (Table 1).

Deposit assessment

Distribution of spray deposits in the canopy was examined by sampling at three canopy levels. The crown of each sample tree was visually divided into an upper, middle and lower level. Starting one hour after application, one branch was collected from each level with a pole pruner and five twigs were taken from each branch. Cut ends of the twigs were wrapped in wet cotton and aluminum foil. Twigs were then placed individually in plastic boxes and transported in coolers to a field laboratory at the airstrip for assessment of deposits and biologi-

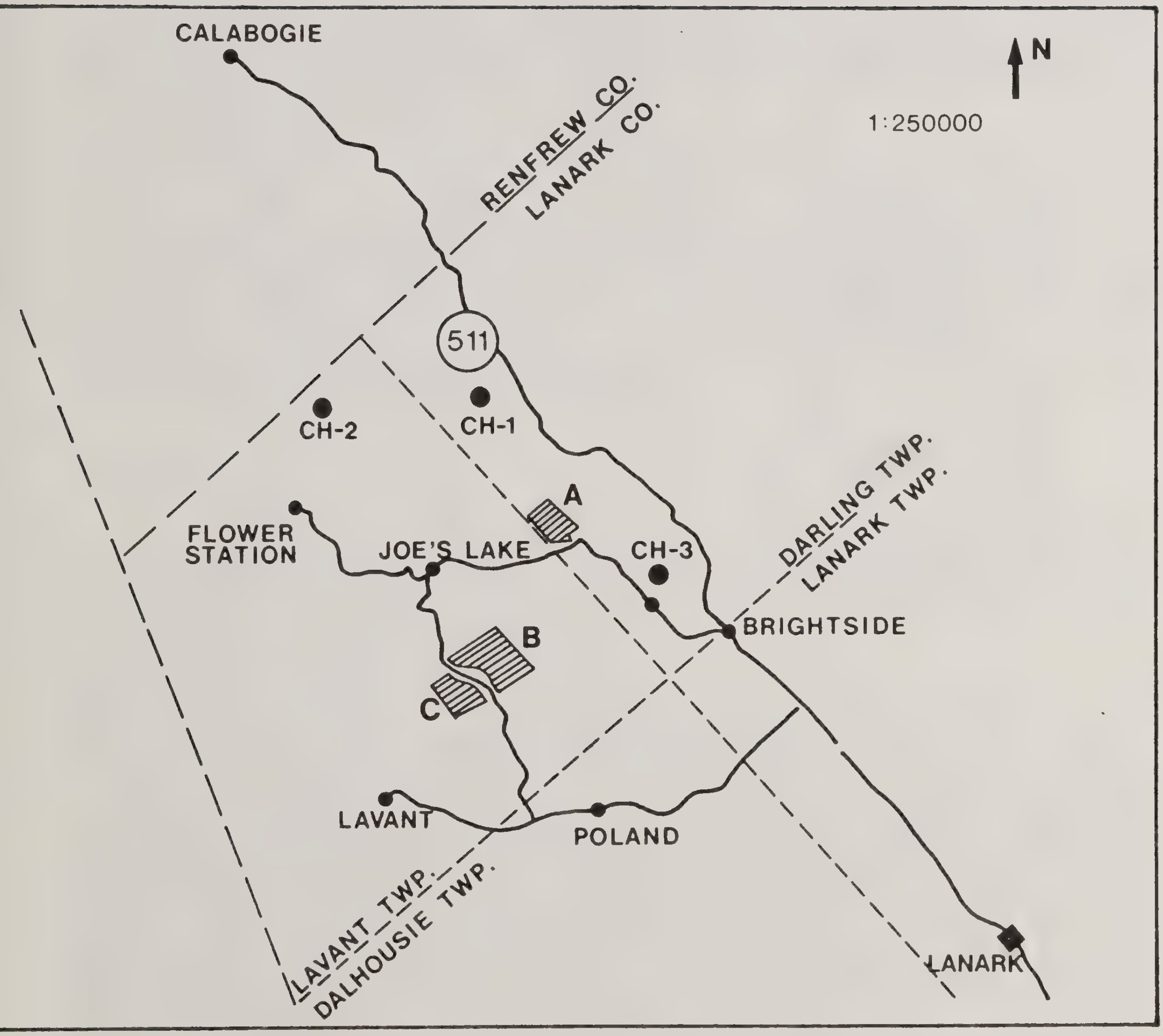

Figure 1. Location of the spray blocks (A, B and C) and untreated checks (1: Napier Hill; 2: Clyde Lake Mountain; 3: French Line) in southeastern Ontario.

cal activity. Spray deposits were estimated by examining one leaf from each twig under the microscope within 5 h of collection. The number of droplets were counted in five randomly selected fields of view for a total of 1.6 cm^2 per leaf surface. Droplet size was estimated by measuring 500 droplets in each treatment, using a Wild Leitz digital length measuring unit (Wild Heerbrug, Willowdale, Ont).

Table 1. Summary of application parameters

	Block A	Block B	Block C
Date of treatment	May 26	May 28	May 27
Size of block (ha)	70	230	50
Foliage expansion	75%	80%	60%
Instar development:			
% first instar	11	10	10
% second instar	46	74	74
% third instar	43	16	16
Time of application	0630-0645	0615-0645	0600-0645
Volume rate (L/ha)	1.8	0.9	6.0
Dosage rate (BIU/ha)	30	15	30
Micronair blade angle	35	35	35
Emission rate (L/min)	33.3	16.6	111
Pressure (psi)	29	38	26
Variable Restrictor #	11	7	bypass

Droplet density estimates were combined for the 15 sample trees in each spray block to obtain an average value from 75 leaves per canopy level. Variation in droplet density among spray blocks and canopy levels was examined by two way analysis of variance (ANOVA). Droplet densities were subjected to log transformation to approach a normal probability distribution. Pairwise, pooled variance t-tests with Bonferroni probabilities were used to compare treatment means within each block (Dixon 1983). The number median diameter (NMD) and volume median diameter (VMD) for each treatment were calculated according to Johnstone (1978). Spray deposits in the undiluted treatments consisted primarily of spherical or hemisperical droplets, indicating complete or near-complete evaporation. Spray deposits in the diluted treatment more than 100 μm in diameter consisted mostly of stains. Stain diameters are reported without conversion to actual droplet diameter.

Bioassay

Biological activity of spray deposits was examined by bioassay of the twigs collected from the three canopy levels. Each twig was placed in a ventilated plastic cage (18 x 8.5 x 4.5 cm) with its cut end in

water and received five early-to-mid third-instar larvae. Larvae came from egg masses that were collected in the fall of the previous year at Rice Lake (Peterborough, Ont). Cages were kept outside, sheltered from rain and direct sunlight. Larvae were transferred to unsprayed foliage on the fourth day and examined for mortality thereafter at 3-4 day intervals until cumulative mortality had stabilized (15-17 days). Natural mortality in cages was determined on 10 twigs collected from unsprayed trees on each treatment day. Larval mortality at each canopy level was related to observed droplet density for three groups of 5 sample trees each (n=15).

Egg mass survey

Egg mass densities were assessed in April and October, using 8 or 9 randomly selected modified Kaladar plots (MKP). These plots consist of 10 x 10 m squares. Egg masses were counted on all tree boles within this area and on the ground in 10 subplots of 1 x 1 m. The reduction in egg mass density was compared with the reduction observed by FIDS in three nearby untreated check blocks (Fig. 1).

Defoliation

Defoliation estimates were conducted by FIDS in late July. One 45-cm branch was collected from the midcrown of 10 trees in each of the MKP's. Defoliation was estimated by scoring the degree of defoliation of each leaf on the branch. Defoliation in the treated blocks was compared with estimates obtained from the three control blocks.

RESULTS AND DISCUSSION

The overall objective of this study was to assess the feasibility of applying undiluted *B. thuringiensis* for gypsy moth control. In 1987 we concluded that ULV application results in more uniform distribution of spray deposits within the canopy, due to better canopy penetration by smaller droplets, and equivalent mortality of gypsy moth larvae when compared to application of diluted product at higher volumes (van Frankenhuyzen et al. 1989). Results of the 1988 study generally support these observations.

The deposit data reported here are based on only one spray block per treatment. Estimates for the other blocks will be reported by RPC at a later date. Preliminary observations based on our data are reported here.

Mean droplet densities were significantly affected by spray treatment and position in the canopy (Table 2). Application of 6.0 and 1.8 L/ha resulted in comparable droplet densities, which were about 2-

fold higher than in the 0.9 L/ha treatment (Fig. 2). Distribution of spray deposits varied significantly within the tree canopy (Table 2). None of the treatments resulted in a uniform distribution of spray deposits throughout the canopy; droplet densities in the upper canopy were always significantly higher than in the lower canopy (Fig. 2). However, the difference between upper and middle canopy was largest in the 6.0 L/ha treatment and was not significant in the two undiluted treatments, despite more advanced expansion of foliage at the time of treatment, suggesting that undiluted application may have resulted in better canopy penetration.

Table 2. Analysis of variance for droplet density on upper and lower leaf surface combined

Source of variation	df	*F*	*P*-value
spray treatment	2	33.3	0.000
canopy level	2	18.0	0.000
spray x canopy	4	1.9	0.102
error	640		

Droplet size distributions were similar in the two undiluted sprays. More than 85% of all droplets were less than 100 μm in diameter (Fig. 3, blocks A and B), resulting in an NMD of 49-55 and a VMD of 117-126 μm. Size distribution in the 6.0 L/ha treatment was broader, with about 55% of all droplets under 100 μm and a larger NMD (98 μm) and VMD (188 μm) (Fig. 3, block C).

Spray deposits in the 1.8 and 6.0 L/ha treatments resulted in comparable mortality of third-instar gypsy moth larvae in the bioassays (respectively 46.1±2.4% and 51.0±3.3%, block average ± SE, n=45). Lower spray deposits in the 0.9 L/ha treatment resulted in significantly lower mortality (30.4±3.2%). Larval mortality on unsprayed foliage never exceeded 5%. Mortality decreased from upper to lower canopy similar to the observed distribution of spray deposits (Fig. 2). There was a linear relationship between mean mortality and mean droplet density on the twigs in each treatment. The relationship was weakest in block C. Regression lines did not differ significantly in either slopes or intercepts (ANOVA of regression coefficients: P=0.213) and were adequately described by a common line (Table 3). A density of 8-10 droplets/cm² was the estimated requirement for 50% mortality. In the 1987 study we obtained a similar estimate for Dipel 8AF applied at 1.8 L/ha but a much higher LD_{50} for application of diluted product (van Frankenhuyzen et al. 1989). The reason for this difference is not readily apparent.

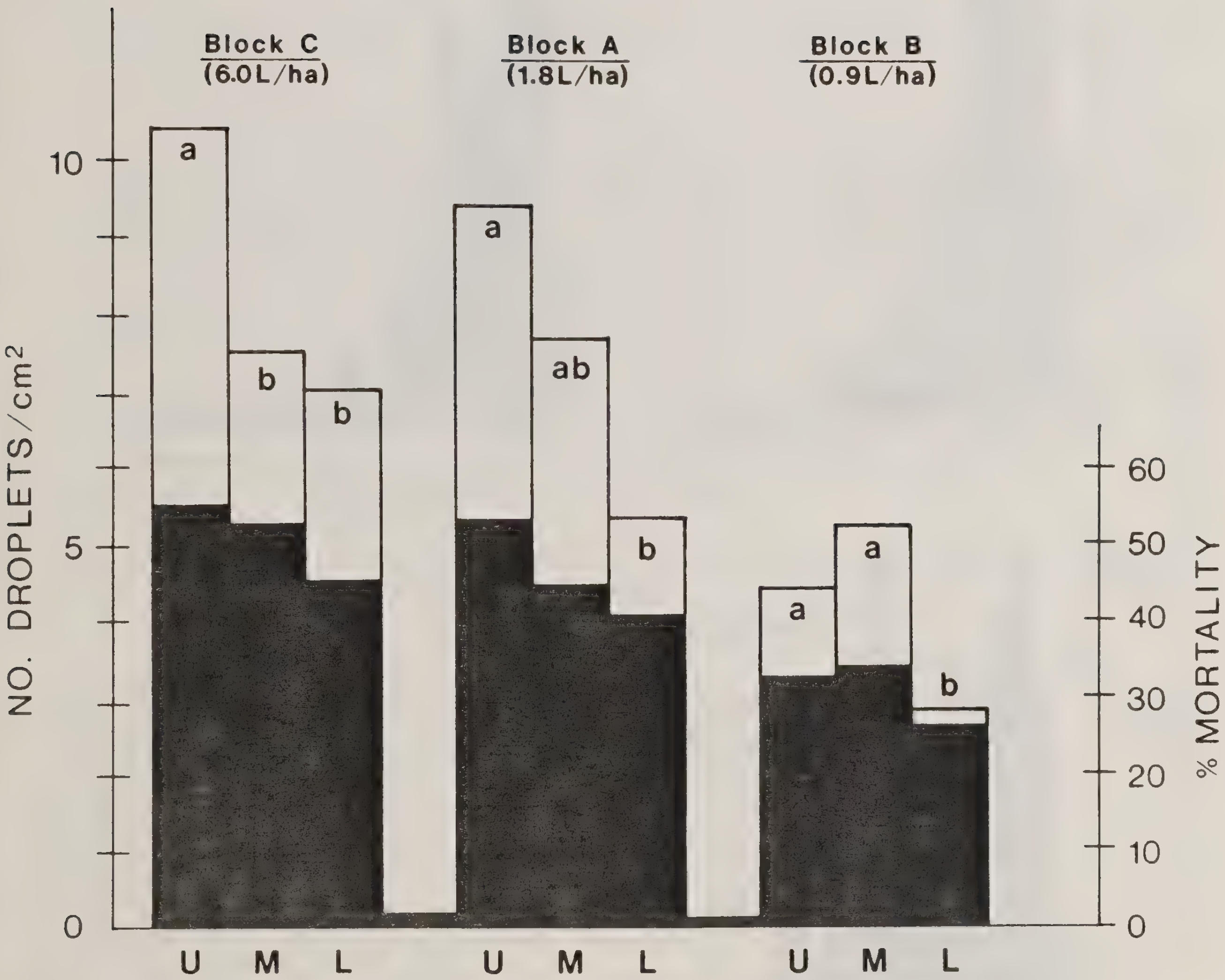

Figure 2. Mean number of spray droplets per cm² (open bars) and resulting mortality of third-instar gypsy moth larvae (solid bars) in bioassays of foliage collected from the upper (U), middle (M) and lower (L) canopy of an oak forest following treatment with Dipel 8AF at 6.0, 1.8 or 0.9 L/ha. Different letters within each spray block indicate significantly different means ($P<0.05$, Bonferroni).

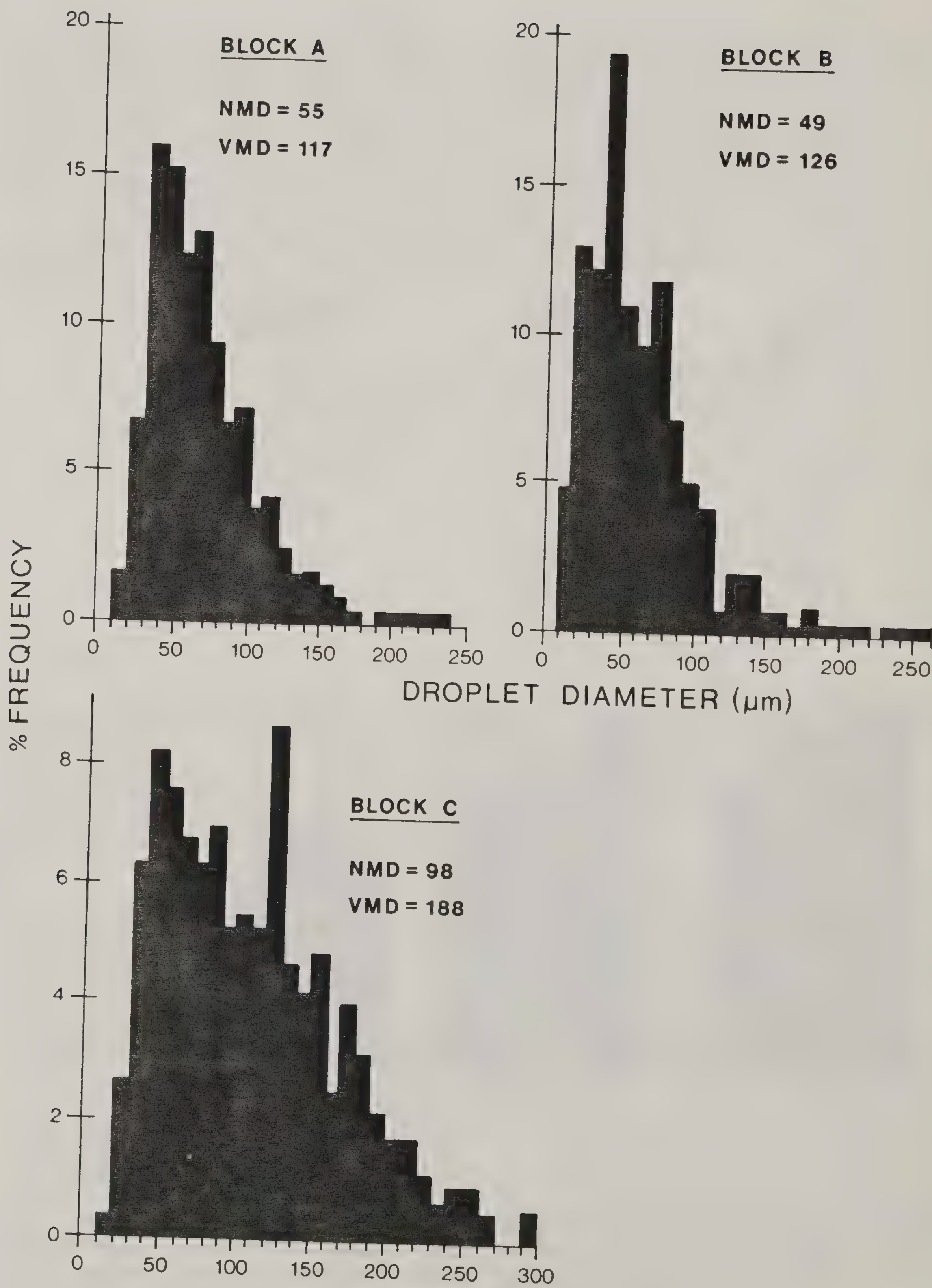

Figure 3. Frequency distribution of droplet sizes observed on foliage after application of 1.8 L/ha (block A), 0.9 L/ha (block B) or 6.0 L/ha (block C).

Table 3. Regression of % mortality of third-instar gypsy moth larvae against droplet density in the bioassays

Block	Treatment L/ha	Regression equation	R^2	*P*	Estimated LD_{50} (droplets/cm^2)
A	1.8	Y = 22.3 + 3.16 X	71.8	0.004	8.8
B	0.9	Y = 16.0 + 3.40 X	53.4	0.025	10.0
C	6.0	Y = 33.8 + 2.08 X	30.8	0.121	7.8
Common		Y = 18.7 + 3.55 X	0.67	0.001	8.8

Larval populations expected on the basis of the spring egg mass counts (Table 4) did not materialize because many egg masses failed to hatch. Low larval populations resulted in low defoliation in the check blocks, ranging from 15-57% with an average of 28% (Table 4). Egg mass densities in the check blocks were reduced by 25-98%, with an average reduction of 75% (Table 4). In the treated blocks, defoliation was consistently lower (12-16%) and egg mass reduction slightly greater (80-90%) than in the untreated areas, indicating that each treatment had a measurable effect. The relative effectiveness of the various treatments, however, remains equivocal because of the low population densities encountered, warranting further studies to confirm our results.

Table 4. Mean defoliation (%) and change in mean egg mass density in treated and untreated blocks

Block	Treatment L/ha	N	% Defoliation (±SE)	No. egg masses/ha (±SE) Spring	Fall	% Change
A	1.8	9	12.3 ± 0.8	3100 ± 664	455 ± 172	85
B	0.9	9	14.7 ± 0.6	1488 ± 340	266 ± 104	82
C	6.0	8	15.6 ± 0.9	2587 ± 505	250 ± 47	90
Check		6	27.8 ± 6.3	6583 ± 1288	1600 ± 698	75

This study demonstrates once again that ULV application of undiluted formulations can result in spray deposits and larval mortality equivalent to application of diluted product in higher volumes. Based on our findings, we recommend application of undiluted formulations containing 16.9 BIU/L at 30 BIU in 1.8 L/ha for operational control of gypsy moth. However, whether such low spray volumes are effective against healthy, increasing populations remains to be determined. The use of lower spray volumes also merits further investigation. Although applica-

tion of 0.9 L/ha in this study resulted in significantly lower spray deposits and less larval mortality, the use of more concentrated formulations may improve results by increasing the effectiveness of low spray deposits. In future programs we intend to assess the effectiveness of highly concentrated formulations that are already available and which can be applied at 30 BIU in 0.9 L/ha or less.

ACKNOWLEDGMENT

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APPENDIX A
Harold Flake

NORTH CAROLINA 1989 GYPSY MOTH TREATMENT SUMMARY

The 1989 Gypsy Moth operations in North Carolina began on Monday, March 27, 1989, with all aircraft reporting for calibration and characterization tests. This year's operation included three spray aircraft (Cessna Ag Trucks), and one observation aircraft (Cessna 180).

The 1989 spray project was the first year this many aircraft were used at one time in North Carolina. It was also the first year that undiluted Bt applications (Foray 48B) were made using Micronair AU5000 Rotary Atomizers. The dose rate for all applicationS was 20 Biu/AC with each site receiving two applications.

Aerial treatment operations began on Monday, April 17, with the first application completed by April 19. The second application was applied starting April 24, and completed on April 27.

Egg mass surveys were conducted prior to insecticide applications at site 1, 3, 4 (see attached sheet) with egg mass densities ranging from 1500-3000 EM/AC in Site 1 and 4 and 3-400 EM/AC in Site 3. Post spray Egg Mass surveys will be conducted in these areas to determine effectiveness of the applications. The attached sheets indicate the 1989 moth and larval catches and summarizes the treatment operations.

1989 GYPSY MOTH INSECTICIDE TREATMENTS
FACT SHEET

GROUND TREATMENTS

	LOCATION	NO. OF ACRES	NO. OF TRTMTS.	TOTAL TRTMT. ACRES	MATERIAL	RATE	EQUIPMENT	RECURRENCE
1.	Henderson (Vance Co.)	2	2	4	Dimilin 25W	2 oz./Ac.	Mistblower	18 moths
2.	Norlina (Warren Co.)	0.5	2	1	Dimilin 25W	2 oz./Ac.	Mistblower	32 moths
3.	Greensboro (Guilford Co.)	4	2	8	Dimilin 25W	2 oz./Ac.	Mistblower	54 moths
4.	Cashie (Bertie Co.)	6	3	18	Foray	20 BIU/Ac.	Mistblower	See aerial site

AERIAL TREATMENTS

	LOCATION	NO. OF ACRES	NO. OF TRTMTS.	TOTAL TRTMT. ACRES	MATERIAL	RATE	EQUIPMENT	RECURRENCE
1.	Cashie (Bertie Co.)	77	2	154	Foray	20 BIU/Ac.	Fixed Wing	638 moths
2.	Grove Hill (Warren Co.)	42	2	84	Foray	20 BIU/Ac.	Fixed Wing	150 moths
3.	Old Trap (Camden Co.)	36	2	72	Foray	20 BIU/Ac.	Fixed Wing	263 moths
4.	Winton-Ferry Ridges (Hertford-Gates Co.)	4,057	2	8,114	Foray	20 BIU/Ac.	Fixed Wing	942 moths
5.	Beech Swamp (Halifax Co.)	47	2	94	Foray	20 BIU/Ac.	Fixed Wing	7 moths

TOTAL TREATMENT ACRES: Ground -- 31
Aerial -- 8,518

NORTH CAROLINA DEPARTMENT OF AGRICULTURE
GYPSY MOTH PROGRAM

1989 BURLAP BANDING SURVEY

County	Site No.	No. of Bands	Total Visits	Positive Sites	Total Larvae
Bertie	1	75	8	yes	692
	2	20	6	no	0
Brunswick	1	25	16	no	0
Camden	1	50	3	yes	1
	2	25			
Carteret	1	50	9	yes	3
Dare	1	20	2	no	0
Edgecombe	1	10	18	no	0
Gates/ Hertford	1	20	5	no	0
	2	15	5	yes	85
	3	14	1	yes	139
Guilford	1	50	6	yes	35
Halifax	1	25	16	no	0
	2	25	24	yes	17
Vance	1	25	14	yes	1
Warren	1	20	14	no	0
	2	25	14	no	0

APPENDIX A
Win McLane

A Report to the National Steering Committee for Aerial Application of Pesticides - Gypsy Moth and Other Eastern Defoliators

Win McLane - APHIS
1989

Field plots, 50 acres in size, were treated in Pennsylvania with Dimilin using low dosages and rates of application. The material was applied to 2nd instar gypsy moth larvae with the APHIS Cessna Ag-truck aircraft. All gallon per acre applications were made with 8004 flat fan nozzle tips with lesser amounts being dispersed through 8002 tips. Dimilin 25W was used for gallon per acre treatments and Dimilin 2F (Special) for lesser amounts. Each treatment was replicated four times.

Immediately following treatment foliage was collected from one plot of the 0.03 lbs. AI/128oz/acre treatments. Some foliage was used for wash-off, fluorometer analysis and the rest of HPLC analysis. At this time analysis results are not complete.

Foray 48B, a new registered Bacillus thuringiensis product from Novo Laboratories, was also tested. The material was applied at 40 BIU/gallon/acre and at 20 BIU/gallon/acre, 2 applications, 8 days apart.

Pre-spray egg mass counts averaged 600 per acre in the treatment area. At time of treatment general foliage expansion was approximately 40 percent. There was no recordable defoliation at time of treatment.

Pre- and post-spray egg mass counts were compared, defoliation recorded and larvae under burlaps counted.

Material	Dosage/Rate	Defoliation	Ave. Larvae under Burlaps	Percent change (EM)
Dimilin 25W	.03 lbs. AI/128oz/A	0-10	1.5	-97.7
"	.015lbs. AI/128oz/A	0-10	0	-97.8
Dimilin 2F(S)	.03 lbs. AI/32 oz/A	0-10	.33	-99.6
"	.015lbs. AI/32 oz/A	0-10	0	-100
"	.03 lbs. AI/16 oz/A	0-10	.66	-99.8
Foray 48B	20BIU/128oz/A (2 app)	0-10	3.75	-98.2
"	40BIU/128oz/A	0-10	.14	-99.1
"	24BIU/64oz/A (neat)	01-0	--	-100
Control	--	20-30	6.88	-31

A cooperative Dimilin study (lower dosages and rates) was conducted in West Virginia with Richard Reardon and Uniroyal Chemical Company. Results are not complete at this time.

APHIS cooperated with Forest Service, State of Virginia and Health Chem in treating approximately 2600 acres of very lightly infested acreage with Disrupt II, the gypsy moth pheromone. No trap catches were made in the

treatment area and no tethered females were mated in the treatment area following application. However, no tethered females were mated in the untreated area outside the treatment area.

The NEFAAT group conducted charterization tests with Foray 48B at Mission, Texas during January 1989. The formulation handled well and break-up and deposit was good. We did see some build-up of material on the outside edges of the nozzle tips. This could be corrected by periodic wash-off with water.

Before calibration, Foray 48B undiluted should be circulated through the aircraft pump for approximately 10 minutes. This will allow it to reach a leveling out temperature.

We also found that the material should not be mixed with Bond sticker.

Wain McLane

W. McLane, Section Leader
Insecticide and Application Technology Section

[illegible] females were [illegible] in the [illegible] were [illegible] in the [illegible]

[illegible] contact action [illegible] 400 [illegible] The formation [illegible] build-up [illegible] on the outside [illegible] This could be [illegible] by periodic wash-off with [illegible]

[illegible] Spray [illegible] be circulated through the [illegible] temperatures.

[illegible] material [illegible] be mixed with [illegible]

[illegible]
Section Leader
[illegible] Application Technology Section

APPENDIX A
Steve Munson
Western
Gypsy
Moth
Activities

1989 UTAH GYPSY MOTH ERADICATION PROGRAM

MT. OLYMPUS COVE TREATMENT SUMMARY

AIRPORT CALIBRATION MEETING - April 26, 1989 Mark Quilter and Steve Munson met with Salt Lake International airport officials to secure a site for aircraft calibration. Airport #2 was approved by airport officials for calibration purposes.

HELIPORT SELECTION MTG. - May 2, 1989 Steve Munson and Mark Quilter met with Classic helicopter owner Brent Henderson, Larry Roe (heliport manager) and the observation pilot to review heliport selection.

AIRCRAFT CALIBRATION - On May 3, 1989 at 0600 the Bell 206-L3 was calibrated at Salt Lake City Airport #2 to determine application parameters. The following individuals assisted in the calibration of the application helicopter:

Julie Weatherby, Entomologist	USFS-Forest Pest Management
Andy Knapp, Biological Technician	USFS-Forest Pest Management
Dawn Cameron, Entomologist	USFS-Forest Pest Management
Steve Munson, Entomologist	USFS-Forest Pest Management
Mark Quilter, Agriculture Inspector	Utah Dept. of Agriculture

The results of this calibration were:

Number of nozzles - 6 Beecomist
Flying height - 50 feet above the canopy
Aircraft speed - 84 Knots, 96.2 mph
Boom pressure - 50 PSI
Flowrate - 1.22 gpm/nozzle, 14.64 gallons/minute
Droplet size - 120-150 microns
Oriface size - D6
Swath width - 100 ft.
Application rate/acre - 97.5oz
Formulation - 1 qt Bt, 2 qts. water and 1.5 oz of Plyac
Other: 120 ft. swath - 70 knots, 80.52mph

PREFLIGHT CONFERENCE - On May 9, 1989 at 0900 a preflight conference and an observation flight was conducted at the Interagency Fire Center to acquaint the application and observation pilots, aerial observer, and treatment chief with spray block boundaries, hazards within the treatment block, emergency landing sites and heliport operations site. During the preflight conference the heliport manager briefed the pilots on safety procedures at the heliport site and the aerial observer described the application program's communication plan. Representatives from the Salt Lake County Sheriff's Department and the Federal Aviation Administration were also present to discuss safety and emergency procedures.

OPERATIONS CONFERENCE - The treatment chief briefed the load checker and field personnel on their responsibilites for the project on May 10, 1989. During this conference card sites, balloon corners, weather information, product mixing and sampling procedures were discussed.

FIRST APPLICATION - The first application was conducted May 11th at 0600. The following summarizes application results:

Weather - Conditions from 0600 to 0730: Wind <10 mph, Wind Direction - East, RH - 55-82%. Conditions from 0900 to 1000: Wind <10 mph, Wind Direction - East, RH - 56-73%. An intermittent light rain fell at the heliport for 10 minutes during the final application. At 1500 hours within the Mt Olympus Cove area thundershowers developed and 1.8 inches of rain fell over a 2 hour period. Intense periods of hail accompanied the thunderstorm. Approximately 5 hours of drying time had elapsed prior to the rainfall.

Airport Operations - The first application began at 0602 MST with 80 gallons of formulation in the first load. Upon return, the pilot felt he could safely carry 100 gallons of material with each load. Flight time for application ranged between 11-15 minutes/load. Average loading time was 3-4 minutes. The heliport site was kept moist to reduce the amount of flying debris as the helicopters landed and took-off. On the 3rd load some problems developed with mixing because the Bt drums weren't properly agitated before pumping. The pump filter became clogged and had to be removed and cleaned. All mixing was done at the time of application. After talking with Frank Hewlitt from Abbott Labs it was determined that the tank mixes could be completed the day before treatment. A total of 980 gallons of formulation was applied in the first application (647.4 gallons of water, 323.7 gallons of Bt, and 8.9 gallons of Playac). Ten loads of material were applied, 5 loads before 0730 and 5 loads after 0900. The first application was completed at 1003 MST. Approximately 3 gallons of Bt was spilled at the loading site when a hose backflushed from the drum. The material was cleaned up using kitty litter and the area was flushed with water.

Field Operations - A total of 78 spray deposit cards were placed at specified locations within the treatment block. Of these, 2 cards were not recovered, 3 cards were saturated by lawn sprinklers, 4 cards had light deposit and the remaining 69 cards had good spray deposit. Of the 4 cards with light deposit, 2 were directly under an oak canopy which would account for the light deposition. Card numbers 32 (Thousand Oaks Circle) and 35 (East Cliff Circle) may have had very light coverage of the Bt material during the first treatment.
The individuals who placed balloons and took the weather data had an abundance of free time during the first application. During applications 2 and 3 their responsibilities were combined with the card placement crews. As a result, the field staff was able to radio information to the treatment chief at a faster rate ensuring more thorough coverage of the spray area and reducing treatment skips.

[illegible] certain bo[illegible] [illegible]
[illegible] [illegible]
d sampling procedures [illegible]

APPLICATION - [illegible]
[illegible]

[illegible] 1 - [illegible]
[illegible], NH - [illegible]
[illegible] - [illegible] 5-758 [illegible]
[illegible] for [illegible]
[illegible]
[illegible] fell [illegible]
[illegible]
[illegible]

Airport Operations - [illegible]
gal[illegible]ons of formulation [illegible]
could safely carry [illegible] gallons [illegible]
[illegible] application rate [illegible]
[illegible] minutes. [illegible]
[illegible] debris on the [illegible]
[illegible] was developed [illegible]
agitated before pumpi[illegible]
[illegible] and cleaned. All mixing [illegible]
[illegible] talking with Frank [illegible]
[illegible] mixes could [illegible]
[illegible] of formulation was [illegible]
water, [illegible] gallons of [illegible]
material [illegible], 5 [illegible]
[illegible] first application [illegible]
[illegible] spilled at the loading [illegible]
[illegible] material was cleaned up using [illegible]
[illegible] with water.

Field [illegible] - A total of [illegible] spray-deposit cards [illegible]
[illegible] locations within the treatment block. [illegible]
[illegible], 3 cards were [illegible]
[illegible] and the remaining [illegible] cards [illegible] spray deposits. [illegible]
[illegible] 2 were directly under [illegible] oak canopy [illegible]
[illegible] for [illegible] deposition. Card number [illegible]
[illegible] may have [illegible]
[illegible] first treatment.
[illegible] placed balloons and took the weather [illegible]
[illegible] during the first application [illegible]
[illegible] were consistent with the [illegible]
[illegible] staff was able to radio [illegible]
[illegible] more thorough [illegible]

Insect development - Instar development was recorded at 3 permanent plot sites: #2 (Zarahemla Dr), #4 (Gilead Way) and #10 (Matthews Way). On May 11th, 82.3% were in the first instar and 17.6% were second instar larvae.

SECOND APPLICATION - The second application began on May 18th at 0557. The following summarizes application results:

Weather - Conditions from 0600 to 0730: Wind speed were <10 mph with the exception of Parleys Canyon where wind gusts up to 16 mph were recorded. Wind direction was from the east in the majority of the treatment block and RH ranged from 28-70 percent. The lowest RH percentages were recorded in Neff's Canyon. Conditions from 0900 to 1000: Wind speed <10 mph, wind gusts in Parley's Canyon had subsided to <10 mph. Wind direction remained from the east and RH had dropped to 35-42 percent. The lower RH percentages were recorded in the mouth of Millcreek and Parley's Canyons.

Airport Operations - The first application began at 0557 MST with 100 gallons in the first load. The amount of material loaded varied between 94 and 110 gallons. The material had been premixed at 1400 hours on May 17th. Average loading time was 1.5 to 4 minutes. Flight time per application averaged 12-15 minutes. A total of 1004 gallons of formulation was applied during the second treatment (660 gallons of water, 330 gallons of Bt, and 15 gallons of Plyac = 1005 gallons of mixed formulation). Ten loads of material were applied, 6 loads before 0730 and 4 loads after 0900. The second application was completed at 0951 MST. No spills were recorded during the loading or the mixing operations.
Field operations - Seventy-seven spray deposit cards were placed at specified card locations within the treatment block. All the deposit cards were recovered, 6 of the recovered cards had light deposit. Card numbers 5 (Parkview Drive), 6 (Mt. Olympus Way), 22 (Zarahemla Drive), 58 (near balloon location #2) and M1 (mouth of Millcreek Canyon) had light coverage on the cards during the 2nd application. As a result of the spray deposit card information, most if not all of these areas were retreated to ensure adequate spray coverage within the treatment block. A skip did occur in the 2nd treatment on Parkview Drive between card locations 3 and 4. This area was marked on the map to ensure adequate spray coverage during the 3rd application.

Insect development - Instar development was recorded at the same 3 permanent plot sites indicated under the first application. On May 19th, 64% were in the first instar, 35.5% were second instar, and 0.5% were in the third instar. Timed larval counts were made at each of the 3 plot locations, an average of 7.76 larvae were counted/minute.

THIRD APPLICATION - The third application was conducted May 25th at 0555. The following summarizes application results:

Weather - Conditions from 0600 to 0730: Wind <10 mph with an occasional gust in Millcreek Canyon to 12 mph. Wind direction was from the east and RH ranged from 45-78 percent. Conditions from 0900 to 1000: Wind speeds decreased to <5 mph. Wind direction continued from the east, RH dropped

to 25-48 percent. A low RH reading (25 percent) was recorded in Neff's Canyon, all others remained above 30 percent.

Airport Operations - The first application began at 0555 MST. Flight time averaged 10-16 minutes and the average loading time was 1.5-3 minutes. Between loads 12 and 13, 24 minutes elapsed due to mixing of additional material. A total of 1293 gallons of formulation was applied during the 3rd application (850 gallons of water, 427 gallons of Bt and 17.5 gallons of Plyac = 1,294.5 gallons of mix). The remaining 1.5 gallons was added to the rinse and deposited within the treatment block boundary. Thirteen loads of material were applied ranging from 84-109 gallons. Six loads were applied between 0600 and 0730 and 7 loads after 0900. Additional material was sprayed during the third application over areas with high populations and on the border areas on National Forest land to ensure complete and effective coverage of the treatment block. The application helicopter returned to the heliport area at 1107 MST completing the aerial phase of the Gypsy Moth eradication program in the Mt. Olympus area.

Field Operations - Eighty-one spray deposit cards were placed within the treatment area during the third application. Of these, 4 cards were missing and not retrieved and 2 cards had light deposition - card numbers 49 (Crestview Drive) and 34 (Thousand Oaks Drive). Both areas were retreated, however the cards were not in place during the retreatment. The area missed on Parkview Drive during the second application was treated twice to ensure full coverage of the skipped area.

Insect development - Instar development recorded at the 3 permanent plot sites on May 25 indicated 56.1% were in the first instar and 43.9% were second instar larvae. Larvae counts taken at these same locations averaged 2.38 larvae/minute. Based on the larval counts made on May 19th, a 70% reduction in larval numbers had occurred following the second treatment.

Post-Treatment Conferences - A conference was held among project personnel following the first and second applications. Items discussed included: project operations, instar development, timing of the next application, product performance and project safety.

Treatment Effectiveness - Ten 1/40th acre plots were established in the treatment block to monitor egg mass numbers. Plots were marked using orange ribbon and metal tags. Pre-treatment egg mass numbers were recorded at each plot. At the end of September, the plots were revisited and egg masses counted. Overall egg mass reduction within the treatment block was tabulated. The following data collected on April 20, 1989 lists plot number, location, host type and egg mass counts:

PLOT #	LOCATION	HOST TYPE	EGG MASSES/ACRE
1	Abinadi Road	90% Oak, 10% Maple	160
2	Zarahemla Way	70% Oak, 30% Maple	640
3	Zarahemla Way	60% Oak, 40% Maple	0
4	Gilead Way	95% Oak, 5% Maple	1,280
5	Neffs Canyon	40% Oak, 60% Maple	0

6	Neff Canyon	90% Oak, 10% Maple	0
7	Boy Scout Camp	10% Oak, 90% Maple	0
8	Mill Creek Canyon	90% Oak, 10% Maple	80
9	Cove Crest	95% Oak, 5% Maple	0
10	Mathews Way	100% Oak, 0% Maple	4,240

The following data was collected on September 29, 1989:

PLOT #	EGG MASSES/ACRE
1	0
2	0
3	0
4	80
5	0
6	0
7	0
8	0
9	0
10	40

Summary - On June 5, 1989 final larval counts were made at the 3 permanent plot sites. An average of 0.35 larvae/minute were counted, which indicates a 95% reduction in larval numbers compared to the original counts conducted on May 19th. The results of the egg mass survey indicate a 98% egg mass reduction within the 10 plots surveyed. However, a skip was noted covering 2.5 acres within the treatment block and egg mass numbers within this area average 200/acre.

No major spills or accidents occurred during any of the 3 applications. Based on current data, the aerial treatment project with Bt can be considered a successful spray operation. A total of 3,600 acres (3,300 private and 300 federal) were treated in the 1989 Gypsy Moth Eradication Program. Project personnel are to be commended for a safe and efficient aerial treatment program.

STATE OF IDAHO
1989 GYPSY MOTH REPORT

prepared by
R. LADD LIVINGSTON
SUPERVISOR, INSECT AND DISEASE SECTION
IDAHO DEPARTMENT OF LANDS

October 30, 1989

In 1989, we conducted gypsy moth projects for both eradication and detection.

ERADICATION

We used both aerial applications of Bt and follow-up mass trapping in our eradication efforts in 1989. We aerially treated 380 acres (110 acres in Coeur d'Alene and 270 acres in Sandpoint) and mass-trapped 817 acres (150 in Coeur d'Alene and 607 in Sandpoint). In the detection survey, combined with the mass trapping, we caught 32 moths in Coeur d'Alene and 29 in Sandpoint. This represents reductions of 67 and 93 percent, respectively, compared to 1988 catches. Egg mass surveys found 4 new egg masses in Coeur d'Alene and 5 in Sandpoint.

The aerial treatment was done with a Hiller 12E Soloy. We used 6 electronic rotary atomizer Beecomist nozzles to deliver 96 oz/ac. Our spray was Abbott's Dipel 8L; 1 quart of pesticide in 2 quarts of water with 2 percent by volume of Plyac sticker.

Mass trapping was done at 9 traps per acre. We checked the traps twice per week through the peak flight period and replaced traps when moths were found.

Project costs were $123.87 per acre for the spraying and $57.78 per acre for the mass trapping with a total project cost of $191.65 per acre.

DETECTION

All major cities and towns in Idaho were surveyed with detection traps at 4 per acre in 1989. We also had traps at many campgrounds and tourist attraction sites. A total of 2,248 detection traps were placed. The effort is a cooperative one with participation by the Idaho Departments of Lands and Agriculture and the USDA-Forest Service Regions 4 and 1. The detection effort trapped 6 moths in an area west of Sandpoint approximately 1.5 miles outside of the treatment zone; 7 moths in Idaho Falls, Idaho, and 1 moth in Pocatello. These last two cities represent new areas. We will conduct delimiting surveys in these new areas next year.

STATE OF CALIFORNIA

DEPARTMENT OF FOOD AND AGRICULTURE

GEORGE DEUKMEJIAN, *Governor*

1220 N Street
Sacramento, California 95814

October 26, 1989

Mr. Steve Munson
Forest Pest Management
U.S. Forest Service
324-25th Street
Ogden, Utah 84401

Dear Mr. Munson:

The California Department of Food and Agriculture maintains a statewide detection program for gypsy moth using trap densities of two traps per square mile in most residential and densely populated rural areas, and three traps per square mile in rapidly growing coastal areas. High risk sites such as campgrounds, recreational areas, mobile home parks, etc., are trapped at a minimum of one trap per site. Upon catching an adult gypsy moth, trap density is increased to 25 traps per square mile in a four-square-mile area around the find. During 1989 this detection and delimitation system caught 33 gypsy moths in 12 counties spread from San Diego to Cottonwood near Mt. Shasta (see attachment). As of August 31, 1989, there were approximately 21,000 gypsy moth traps in place.

In addition, most incoming moving vans from gypsy moth infested areas of the East have their contents inspected upon arrival. If there are any signs of gypsy moth eggs, larvae, or pupae, 25 traps are deployed in a square-mile area around the move-in site. The quarantine traps caught 23 gypsy moths in 1989 in three counties with the majority (15) coming from the City of Tiburon in Marin County.

In total, 56 adult gypsy moths were captured in 14 counties, with the greatest number coming from Marin County (25) and San Diego County (8). Egg mass surveys, conducted around all multiple trap catches, found egg masses at single sites in Marin and Placer Counties. A limited treatment program using either Dimilin or Bt from the ground is being planned for these locations in 1990. The source of infestation for both sites has been specifically

identified to residents arriving in 1988 from high hazard areas in the Northeastern U.S. It is possible that the La Mesa site in San Diego County may be treated in 1990, pending further egg mass surveys.

Trap densities of 25 traps per square mile over a four-square-mile area will be maintained around all single moth capture sites for 1990.

Sincerely,

John Connell

John Connell
Program Supervisor
Pest Detection/Emergency Projects
Division of Plant Industry
(916) 324-3761

Attachment

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE
Pest Detection/Emergency Projects

SUMMARY - 1989 GYPSY MOTH FINDS

COUNTY	<--ADULTS TRAPPED--> DETECTION	QUARANTINE	TOTAL ADULTS	PROPERTIES WITH VIABLE EGG MASSES/ PUPAL CASES
ALAMEDA	2	0	2	0
Berkeley (2)				
LOS ANGELES	4	0	4	0
Chatsworth (1)				
Newhall (1)				
Sun Valley (1)				
Woodland Hills (1)				
MARIN	6	19	25	1
Fairfax (2,0,0)				
Novato (0,1,0)				
San Anselmo (2,0,0)				
San Rafael (0,3,0)				
Tiburon (2,15,1)				
NEVADA	3	0	3	0
Grass Valley (3)				
ORANGE				
Anaheim (1)	2	0	2	0
Fullerton (1)				
PLACER	0	3	3	1
Roseville (0,3,1)				
SACRAMENTO	1	0	1	0
Carmichael (1)				
SAN DIEGO	8	0	8	0
La Mesa (7)				
Valley Center (1)				
SAN JOAQUIN	1	0	1	0
Manteca (1)				
SAN MATEO	1	0	1	0
Menlo Park (1)				
SANTA CLARA	0	1	1	0
San Jose (1)				
SHASTA	2	0	2	0
Cottonwood (2)				

TUOLUMNE Sonora (1)	1	0	1	0
VENTURA Thousand Oaks (2)	2	0	2	0
	33	23	56	2

9-6-89

Colorado State Forest Service
Colorado State University
Fort Collins, CO 80523

RECEIVED
OCT 30 1989
SPM

October 26, 1989

Steve Munson
USDA - Forest Service
Forest Pest Management
325 25th Street
Ogden, Utah 84401

Dear Steve,

Here is a real hasty and rough summary of our gypsy moth program for you to use with your report back East.

KNOWN CITIES WITH SOME LEVEL OF GYPSY MOTH INFESTATION PRIOR TO SUMMER 1989

Boulder (first found in 1985 via detection trapping)

Fort Collins (first found in 1985 via detection trapping)
"East" infestation
"West" infestation

Lakewood (first found in 1987 via detection trapping)

All three of these received detection (1/square mile), delimitation (25/square mile), and mass (9/acre) trapping. Areas represented by (+) catches in previous years were mass-trapped. Delimitation "doughnuts" of ¼ mile were placed around the mass-trapped areas. Detection trapping was installed for the rest of the respective city areas.

All cities and towns in the state were trapped, plus potential problem spots. Total traps installed in Colorado during 1989: approximately 3900.

Six properties in Boulder were sprayed from the ground with *Bacillus thuringiensis* (Dipel 4L) at a rate equivalent to 16 BIU's/acre, three times in May.

Five properties in Fort Collins ("West" infestation area) were sprayed according to the same scheme.

1989 RESULTS

Boulder: 0 male catches for 1989 following aerial applications of Bt in 1988 and small-scale ground applications this year. This infestation is tentatively considered eradicated. Probably limited mass-trapping will be employed next year as a precaution.

Fort Collins ("East"): 5 males (1 moth in each of 5 traps). This area treated with induced inherited sterility (="F1") technique in 1988, mass-trapping only in 1989. Tentative plans are to spray 3-4 block area with Bt from the ground in 1990.

Fort Collins ("West"): 0 male catches for 1989, following large-scale ground spraying in 1988 and small-scale ground spraying (both with Bt) in 1989. This infestation is conditionally viewed as eradicated. Limited trapping is planned for 1990 as a precaution.

Fort Collins (general): 2 outlying catches in 1989 at locations widely separate from known infestations. These specific sites will be mass-trapped in 1990 to determine if they are new introductions or stray moths tied to the two known problem spots.

Lakewood: 0 male catches in 1989. This area was mass-trapped in both 1988 and 1989, but no spraying took place (that we know of). The 0 catch is a mystery, unless landowners undertook treatments on their own that took care of the population via spraying or host removal. Plans are to mass-trap again in 1990. (FYI, the high annual male catch in this area was 43 moths in 1988).

NEW LOCATIONS DISCOVERED VIA DETECTION TRAPS IN 1989:

Limon: 1 moth

Colorado Springs: 1 moth (1 moth was trapped here in 1987 in almost the same location. Trapping in 1988 was negative. Extended diapause?)

NEW LOCATION DISCOVERED VIA CITIZEN INPUT IN 1989:

Westcliff: 10 egg masses and 1 live female confiscated from "outdoor household articles" brought into CO from New Jersey. Landowner alerted us to this situation. This area will be monitored with traps in 1990.

In summary we feel we are very close to eradication in our three cities with established gypsy moth infestations. We feel both aerial and ground applications of Bt can be effective, particularly when increasingly-dense trapping is used to focus the treatment area. Mass-trapping is at least a partial control technique. Every effort to obtain and incorporate citizen input regarding trapping and control operations is worth the effort. Detection trapping is a very effective way to discover new infestations.

Dave Leatherman DAL
Entomologist
(303) 491-6303

APPENDIX A
Michelle Frank

PRELIMINARY REPORT

VERMONT PEAR THRIPS PILOT STUDY

MAY 17, 1989

Introduction

The Vermont Pear Thrips Pilot Study tested the effectiveness of Sevin Brand 4 Oil in reducing pear thrips populations and preventing sugar maple leaf injury. Two timings were tested. The first timing, at first emergence of thrips from the soil, was completed on April 26. The second spray timing, at peak emergence of thrips from the soil, was completed on May 4. Spray plane calibrations were accomplished in Fryeburg, Maine from April 20 to 22, to obtain a V.M.D. of 270 and 30 drops per square centimeter.

Application Specifications

All aerial spraying was done using a Grumman AgCat fixed wing airplane operated by Les Hill from Fryeburg, Maine. Twenty-two flat fan nozzles (8004) were placed on the spray boom to obtain an application rate of 9.77 gallons per minute under 40 lbs of pressure. Spray mix contained Sevin Brand 4 Oil mixed with deoderized kerosene and two dyes: Rhodamine Red WT and Key Tect Tracer Yellow R. The red dye faciliated use of the swath kit spray card analizer and the yellow dye was added to make it possible to count spray droplets on sugar maple twigs using an ultra violet light. One pound per acre active ingredient was used with a spray mix of 32 oz. of Sevin Brand 4 Oil and 32 oz. of kerosene for a total of 64 oz. per acre. The dye was added at 1% red dye and 0.1% yellow dye.

The spray plane operated at 100 mph and acheived a 100 foot swath width. During the first and second spray applications, 137 and 263 acres were sprayed, respectively, to total 400 acres sprayed.

A monitor plane was used during spray application to facilitate plot location and to record application information. Radio communication was maintained between the monitor plane and the spray plane, and between ground crews and the monitor plane. Two meteorological stations were established on each spray day, to monitor weather conditions throughout the spray operation. Local wind information was also monitored using hand held animometers and smoke bombs.

Evaluation

Prior to plot set-up, soil samples were taken in all plots to determine pear thrips population levels. Plots with an average of seven thrips per bulb planters worth of soil were selected as spray or check plots. Plot boundaries were marked, and 10 sample trees were lelected in a line running diagonally from opposite corners of the plot. Ten emergence traps were placed in each plot to monitor thrips emergence from the soil on a daily basis.

Tree climbers were used to take twig sample from each of 10 sample trees per study plot. A total of 360 - 4 cm. twig samples (including apical bud(s)) per plot were taken prior to each spray application to establish numbers of thrips per bud in spray and check plots. Five spray plots and 4 check plots were used for each spray timing for a total of 18 treatment plots. Sampling was repeated approximately 3 days post-spray. These bud samples are currently being processed to determine spray effectiveness in reducing pear thrips populations.

In addition, equal number of twig samples were taken for counts of spray droplets at three heights of the canopy. These will be processed to count numbers of droplets on and near buds.

In early June, climbers will be used to clip additional branches for use in evaluating leaf size, leaf injury, and oviposition sites. All 18 plots will be sampled and twigs processed. This information will be complemented by ground and aerial damage assessment to be done in early June.

New England & New York Insect Conditions 1989

Eastern Spruce Budworm

Spruce budworm defoliated acreage has continued to be low with 5,000 acres in Maine. No defolition was reported in other states. Pheromone trapping confirm low population levels. This trend is expected to continue in 1990.

No suppression projects were undertaken in 1989, with none planned in 1990.

Defoliation by Spruce Budworm
in 1988 and 1989

Region/State	Area Defoliated 1988 (Ac)	Area Defoliated 1989 (Ac)
Northeast		
New Hampshire	0	0
New York	0	0
Maine	64,951	5,000
Vermont	0	0

Gypsy Moth

Gypsy moth defoliation increased throughout New England and New York except for Rhode Island. There was a total of 555,287 acres defoliated in 1989 compared to 19,882 acres in 1987. No control projects were undertaken in 1989, however there are requested for funding to spray 38,200 acres in 1990 (Table A, below).

A fungi, Entomophaga, killed large numbers of gypsy moth larvae in many areas throughout New England and New York. In some cases entire populations were dramatically reduced. We don't know the long-range impact on this gypsy moth outbreak.

Dan, Morgantown has all the G.M. maps digitized in their GIS.

Defoliation by Gypsy Moth
in 1988 and 1989

Region/State	Area Defoliated 1988 (Ac)	Area Defoliated 1989 (Ac)
Northeast		
New Hampshire	1,015	18,400
New York	15,700	421,138
Maine	100	15,000
Vermont	703	21,377
Massachusetts	0	950
Connecticut	1,639	78,430
Rhode Island	725	0

Table A.

Cooperative State and Federal Gypsy Moth
Suppression Projects - 1990

State or Federal Site	B.t.	
Vermont	6,000	
Massachusetts	25,000	
	500	Foci Project
Green Mountain NF, VT	3,700	
White Mountain NF, NH	3,000	
Total	38,200	

Forest Tent Caterpillar

The forest tent caterpillar was reported in New York where about 1,500 acres were visibly defoliated in 1989.

Hemlock Woolly Adelgid

The hemlock woolly adelgid was reported in NY, CT, RI, and MA in 1989. Massachusetts is the most recent state to confirm the adelgid's presence. It was first reported on two backyard trees this spring, and then the adelgid was confirmed nearby in a city park where several dozen trees are infested. The adelgid has also spread to new sites in CT and NY, bringing the total acreage infested to 2,500 and 4,000 acres respectively.

There were no control projects in 1989. Both Massachusetts and Rhode Island are considering ground applications in 1990 to eradicate their newly established infestations.

Pear Thrips

The pear thrips damaged far less acreage in 1989 compared to 1988. For example, Vermont reported less than 10,000 acres damaged in 1989 compared to about 450,000 acres in 1988. New Hampshire and Massachusetts reported similar damage reductions. These 3 states were the hardest hit in 1988. Vermont noted that this sharp damage reduction was not accompanied by a collapse of the pear thrips population. Thrips were abundant in 1989, they simply did not cause the damage observed in 1988. The difference is thought to be the result of different synchrony between host and insects.

The Vermont Department of Forest, Parks and Recreation in cooperation with the USDA Forest Service carried out a pilot control project against pear thrips in 1989. Sevin 4 Oil was applied by an AgCat on 400 acres (137 acres treated early and 263 acres treated later). The treatment evaluation is continuing although the lower than expected 1989 damage will complicate the analysis.

PEAR THRIPS DAMAGE IN VERMONT
Summary of Aerial Survey Results for 1989

County	ACRES DAMAGED IN EACH CATEGORY Light	Moderate	Heavy	Total
ADDISON		400		400
BENNINGTON				0
CALEDONIA	150			150
CHITTENDEN		870		870
ESSEX				0
FRANKLIN		135		135
GRAND ISLE				0
LAMOILLE		244	440	684
ORANGE				0
ORLEANS				0
RUTLAND				0
WASHINGTON		935		935
WINDHAM				0
WINDSOR				0
TOTAL	150	2584	440	3174

APPENDIX A
Barry Towers

YOU CAN USE THIS

Appendix A-5

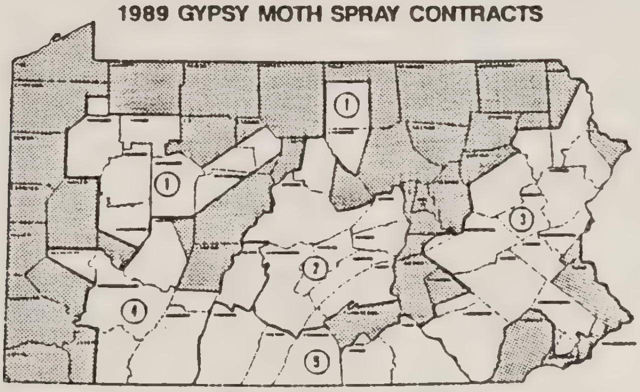
Pennsylvania Bureau of Forestry
1989 Gypsy Moth Suppression Project
A Summary

Acres Treated by Ownership and Insecticide

Ownership	Bt		Dimilin		Total	
	Acres	Blocks	Acres	Blocks	Acres	Blocks
Private	83,684	1,326	1,180	6	84,864	1,332
State Forest	885	9	90,013	170	90,898	179
State Parks	7,943	10	10,758	40	18,701	50
Federal	170	6	-	-	170	6
Other	20	1	1,113	7	1,133	8
Totals	92,702	1,352	103,064	223	195,766	1,575

Contract Areas

1989 GYPSY MOTH SPRAY CONTRACTS



Spray Aircraft Used

Contract 89-1
- 3 - Bell 204
- 1 - Bell 206
- 2 - Hughes 500D

Contract 89-2
- 1 - Bell 204
- 3 - Bell 206

Contract 89-3
- 1 - Bell 206
- 1 - Bell Soloy
- 3 - Sikorsky S55

Contract 89-4
- 1 - Bell 204
- 1 - Bell 206
- 1 - Bell 47G

Contract 89-5
- 1 - Bell 204
- 1 - Bell 47G
- 2 - Bell Soloy

Miscellaneous

Start Date: May 9, 1989 Finish Date: June 7, 1989

Insecticides: Bt-Dipel 8AF, 16 BIU, 1 gallon/acre (24,761 acres)
Bt-Dipel 8AF, 20 BIU, 40 ounces/acre undiluted (1,032 acres)
Bt- Dipel 8L, 16 BIU, 1 gallon/acre (66,909 acres)
Diflubenzuron-Dimilin 25W, .25 ounce AI, one gallon/acre (103,064 acres)

Contract Costs - 1989 Gypsy Moth Suppression Project

Contractor	Contract	Bid Price		Acres Treated		Gallons Applied		Actual Cost/Acre		Contract Cost		
		Bt	Dimilin	Bt	Dimilin	Bt	Dimilin	Bt	Dimilin	Bt	Dimilin	Total
AgRotors, Inc. Gettysburg, Pa.	89-1	$13.97	$11.56	14,271	28,923	14,501	28,923	$14.20	$11.56	$ 202,578.97	$ 334,349.88	$ 536,928.85
AgRotors, Inc.	89-2	13.62	11.21	5,504	41,389	5,504	41,396	13.62	11.21	74,964.48	464,049.16	539,013.64
Cordoba Helicopter Enterprises, Inc.* Hightstown, N. J.	89-3	14.70	11.98	46,229	923	46,846	923	14.90	11.98	688,636.20	11,057.54	699,693.74
AgRotors, Inc.**	89-4	15.35	12.81	11,522	4,454	12,403	4,454	16.52	12.81	190,386.05	57,055.74	247,441.79
Helicopter Applicators, Inc. Frederick, Md.	89-5	15.23	8.53	15,176	25,495	16,690	25,495	16.75	8.53	254,188.70	217,472.35	471,661.05
Option II	-	-	9.00	-	1,880	-	1,880	-	9.00	-	16,920.00	16,920.00
All		$14.69	$10.78	92,702	103,064	95,944	103,071	$15.22	$10.68	$1,410,754.40	$1,100,904.67	$2,511,659.07

Subcontractors:

*Cane Air, Inc., Belle Rose, Louisiana

*Teryjon Aviation, St. Peter, Minnesota

**Helicopter Systems, Inc., Scottdale, Pennsylvania

APPENDIX B

OPERATING GUIDELINES
FOR
NATIONAL STEERING COMMITTEES
CONSIDERING
FIELD TESTS AND PILOT PROJECTS
FOR THE
AERIAL APPLICATION OF PESTICIDES

MEMBERSHIP: Committees members should be nationally recognized research, developmental, and applied scientists as well as natural resource professionals drawn for the most part from the Forest Service but also from other Federal and State agencies.

PURPOSE: The committees' primary tasks are to analyze, identify, and recommend field and pilot testing needs for aerial application of pesticides. Needs include those associated with pesticides, application systems, techniques, and strategies that influence the FS's and State cooperators ability to use pesticides safely, effectively, and in an economically, and environmentally acceptable manner.

PROCEDURES:

The committees shall:

- meet at least annually, preferably during late summer or early fall so recommended projects can be considered for approval, funding, and implementation the next field season.

- focus on sound science that may lead to improving pesticide application consistent with its stated purpose.

- assign priorities to testing needs agreed to by the committee.

- review data and progress of field and pilot tests.

- suggest who might conduct future tests and where the tests might be conducted.

- take action to address needs such as development of guidelines for field test and pilot projects, database formats, and literature studies.

- establish sub-committees to pursue single issues such as review of laboratory and field test data.

The members shall:

- determine pesticide application needs within their geographical, administrative or organizational area prior to each meeting.

- be cognizant of all appropriate Region/Area/Station/State/cooperator needs.

- bring to the meeting needs that have been discussed with line officers and staff.

- represent the unit's needs within the national perspective of the committee.

The Director FPM/WO shall:

- coordinate the report recommendations within WO, and with the Regions, NA, and Stations as appropriate.

- review the steering committee recommendations and resultant FPM project proposals for funding.

- give strong consideration to the steering committees recommendations in prioritizing project proposals for funding.

- complete project approval and funding by January for projects funded by FPM.

APPENDIX C
Dennis Hamel

United States Department of Agriculture | Forest Service | WO

Reply to: 2150 Date: October 13, 1989

Subject: Trip Report to GM/Bt Meeting

To: Max Ollieu

On October 11-12 I attended the gypsy moth (GM)/Bacillus thuringiensis (Bt) meeting in Middletown, Pennsylvania. The meeting was sponsored by an ad hoc committee of State and Federal government personnel and industry and user-community representatives. A copy of the agenda and list of members is enclosed. The meeting was quite productive with good discussion on a wide variety of subjects related to GM and Bt.

One purpose of the meeting is to review the past season's activities and identify needed laboratory and field research for the next season. Listed on the enclosed sheet are the unprioritized list of items discussed. In addition, Enclosures 3-5, identify the recommended research efforts said to be needed by Abbott, NoVo, and Ecogen respectively.

Norm DuBois will prepare a set of minutes from the meeting. At that time these research needs will be prioritized (based on a blind vote of the membership) and recommendations will be made to the FS Eastern Defoliator Steering Committee and others.

At the meeting I was asked to discuss several issues pertaining to FS policy and direction on field experiments, pilot projects, and good laboratory practices (GLP).

The committee was aware of FS efforts to develop guidelines for the conduct of field experiments and pilot projects and they are very supportive of them. Considerable discussion took place on the subject of qualifications of aircraft pilots; however, it was finally decided that this subject was better left to contracting and not be a part of the present guidelines. I concurred and will send recommended language to Jack Barry who can coordinate with Pat Shea.

On the subject of GLPs it was also recommended that the FS and others expedite the preparation and dissemination of guidelines for compliance with 40 CFR 160 (FIFRA) and 40 CFR 792 (TSCA). The Agricultural Research Service (ARS) is ahead of the FS in this regard and Raph Webb offered an example of what ARS scientists are required to do on a daily basis. The FS needs to follow up with Charles "Deacon" Smith and Paul Schwartz (344-3256) on this subject.

In summary, this was a good meeting. It provided a forum for open discussion and the WO should attempt to continue its involvement with the group in the future.

/s/ DENNIS R. HAMEL

DENNIS R. HAMEL
Pesticide Specialist

Enclosures (9)
- Agenda
- Research Needs
- Abbott Research Priorities
- NoVo Research Priorities
- Ecogen Research Priorities
- Guidelines for Field Experiments
- Guidelines for Pilot Projects
- ARS GLPs
- General Information

cc: without enclosures
J. Barry
T. Hofacker
J. Space
N. DuBois

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